

# Identification of Emissions Sources for Pinal County ADOT Project TOD04-04

## Projected Change in Ozone Precursors

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## Overview

The analysis of predicted changes in ozone precursors was initiated because of concern that growth in travel in Pinal County might result in violation of the National Ambient Air Quality Standards for ozone. At the start of the study, forecasts for the population growth in the county suggested that a four-fold increase in population was likely to occur over the next twenty years from the existing population of roughly 250,000. With this growth would certainly come a dramatic increase in vehicle miles of travel. The purpose of the work in this task of the project was to assess whether the growth in population and vehicle miles of travel was likely to result in an increase in the emission of ozone precursors over the next twenty years.

Ground level ozone is a colorless gas produced when sunlight and heat stimulate reactions between volatile organic compounds (VOC) and nitrogen oxides (NO<sub>x</sub>). Ozone formation can occur as a result of VOC and NO<sub>x</sub> emissions anywhere within a regional air basin or even as a result of emissions blown in from another air basin. As a result, it is difficult to identify the source or location of the pollutant emissions that contribute to ozone formation and the concentration at particular monitoring site. Elevated levels are generally recorded during the summer months and can aggravate respiratory problems, especially in sensitive groups. Sources of ground level ozone precursors include passenger vehicles, truck, other gasoline powered motors, industrial processes and biogenic emissions from animals, plants and soil. Although not the only sources of precursor emissions for ozone, traffic-related emissions are the primary source in Pinal County.

Two standards for ozone concentrations have been developed: a one-hour standard and more recently an eight-hour standard. The one-hour standard is 0.12 parts per million (ppm) and can be exceeded only once in a year without violating the standard. The eight-hour standard requires that the three-year average of the fourth highest daily eight-hour maximum average be less than or equal to 0.084 ppm. Pinal County has not violated the one-hour standard in the past ten years. Pinal County and has also not violated the eight-hour standard since the standard was developed but has had three-year averages of the fourth highest day at the Apache Junction and Casa Grande monitoring stations that were just under the standard.

Because of the manner in which ozone is formed, ozone concentrations are a product of regional emissions of the precursor pollutants, sunlight, heat and meteorological conditions. The concentrations measured at a monitoring site cannot be attributed to the emissions of pollutant in the vicinity of the site. As a result, the focus of the work in this task has been on how future emissions of VOC and NO<sub>x</sub> from on-road travel in Pinal County are likely to contribute to regional ozone formation. Although the readings of ozone concentrations at monitoring sites in Pinal County have

raised the concern about ozone in the county, the work in the task did not attempt to determine how changes in travel volumes would affect the concentrations at those sites. Because considerable resources are required to operate photochemical models to evaluate the significance of ozone precursor emissions, analysis of ozone was based on estimates of the ozone precursor emissions and not on estimates of ozone concentrations.

The ozone analysis for the project was conducted by estimating the probable changes in VOC and NO<sub>x</sub> emissions over time as growth in population, employment and travel occur in Pinal County. The estimates of emissions were developed by applying the VMT estimates derived from available travel models by estimated average rates of emissions per vehicle mile traveled. There was not a single accepted source of forecasts of travel or growth for the county, but two forecasts were available for comparison. One set of forecasts was developed by the Maricopa Association of Governments (MAG) and one was developed by ADOT consultants for the Pinal Corridors Planning Model (PCPM). Average emission rates were derived using information from a recent MAG conformity analysis prepared for the Regional Transportation Plan Update. With these estimates of precursor emissions the possible implications for changes in ozone precursor emissions was analyzed.

## Population and Employment Forecasts

Figure 1 provides a comparison of the future forecast of population in Pinal County as a percentage of existing (2006) population. The current population of Pinal County is roughly 250,000. Both the MAG forecast and the PCPM forecast estimate a 2026 population of roughly 1,000,000. That would constitute an average annual compound growth rate of roughly 6.5% in the MAG forecast and 6.9% in the PCPM forecast.

**Figure 1: Comparison of Future Forecasts of Population in Pinal County as a Percentage of Existing (2006) Population**

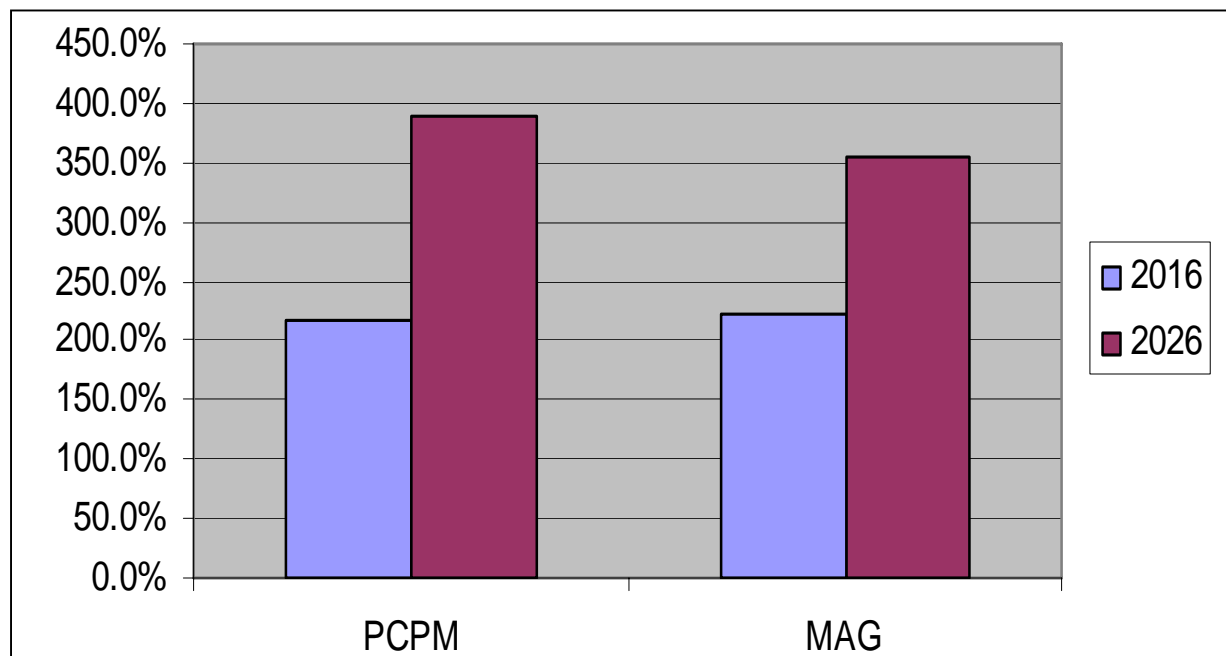
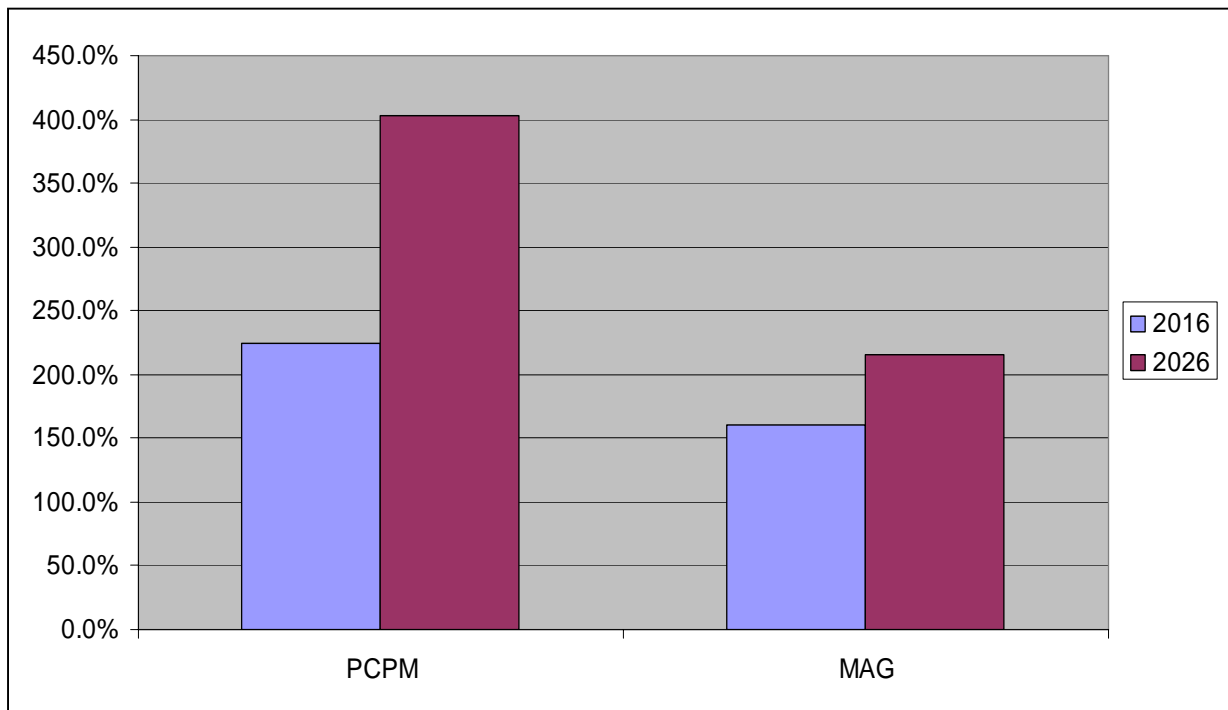


Figure 2 provides a comparison of the future forecast of employment in the county. The two forecasts provide somewhat different estimates of existing employment ranging from 50,000 to 70,000 and vary considerably in the 2026 forecast. The MAG forecast predicts roughly 100,000 jobs in the county while the PCPM forecast predicts roughly 300,000. The average annual compound growth rate in the MAG forecast is roughly 4% per year, while the PCPM average is 7.2% per year. The PCPM forecast maintains a constant ratio of population to jobs of roughly 3.6. The MAG forecast reflects an increase in the ratio from a current level of 5.6 residents per job to 9.2 residents per job in 2006.

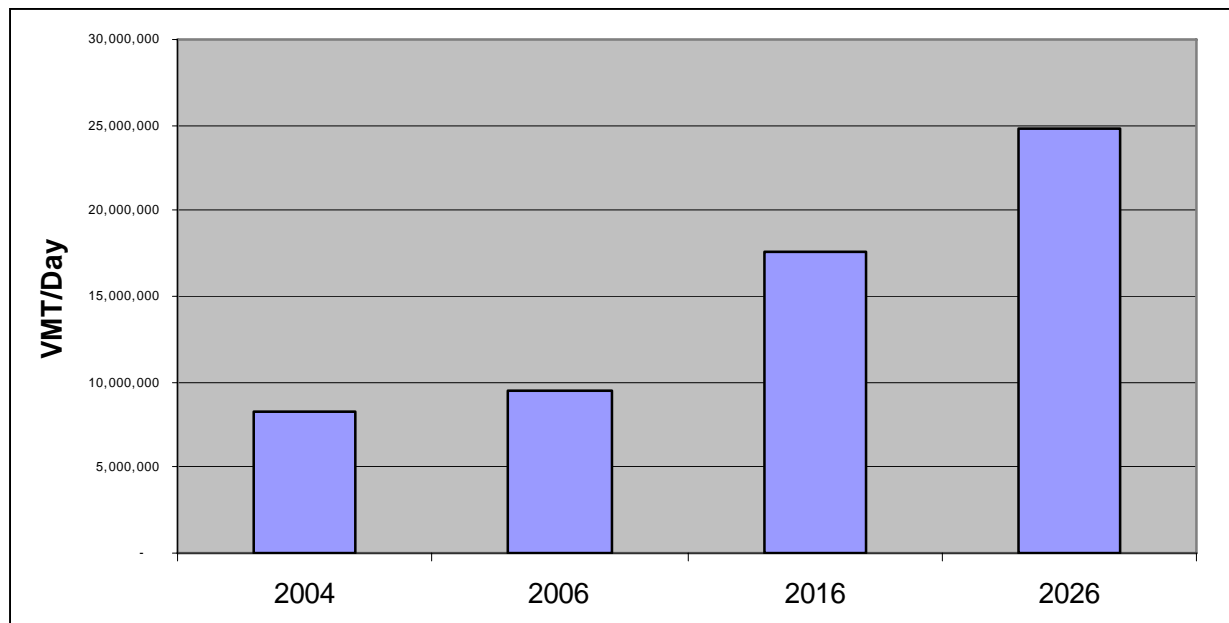
**Figure 2: Comparison of Future Forecasts of Employment in Pinal County as a Percentage of Existing (2006) Employment**



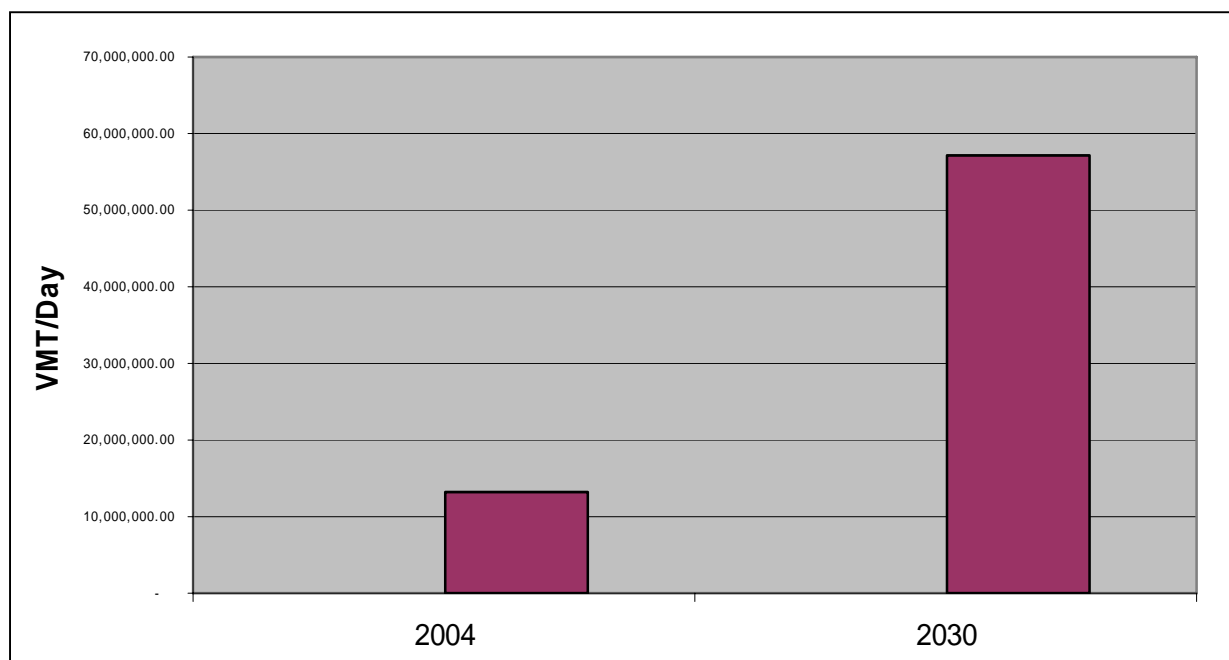
## Travel Forecasts

Travel forecasts from both models were available and also compared. Figure 3 illustrates the expected volume of traffic predicted by the MAG model in the form of vehicle miles traveled per day in the county. The change from 2004 to 2026 reflects an average annual rate of increase of 5.1%. This is in contrast to the average annual rate of growth in population in the MAG forecast of 6.5%. The lower rate of VMT growth reflects a higher percentage of future Pinal County travel remaining within the county as more employment is added. Figure 4 provides VMT estimates for 2004 and 2030 from the PCPM travel forecast. This change reflects an average annual growth of 5.8% per year compared to the PCPM average growth in population of 6.9% per year.

**Figure 3: Estimated Growth in Travel Based on MAG Forecast**



**Figure 4: Estimated Change in Travel Based on PCPM Forecast – 5.8% per Year**



## Estimation of Ozone Precursor Emissions

The ozone analysis for the project was conducted by multiplying the VMT estimates derived from each of the two models compared by the estimated average rate of emissions per vehicle mile traveled for both of the ozone precursors. VOC and NO<sub>x</sub> emissions were estimated for 2006, 2016 and 2026 using the MAG forecast and the MAG average emission rates derived from the RTP conformity analysis. The same emission rates were applied to the PCPM forecast for the years 2004 and 2030. With these estimates of precursor emissions the possible implications for changes in ozone precursor emissions was analyzed.

Figure 5 shows the Maricopa County area non-attainment areas analyzed in the MAG conformity analysis. Two areas were treated separately: the core area inside the green line (the eight-hour non-attainment area) and the “donut” area which is the remainder of the area in Figure 5. Although the donut area did not include Pinal County, the travel characteristics in the donut area were assumed to be more similar to Pinal County than the travel characteristics in the core area.

**Figure 5: Maricopa County Area Non-Attainment Areas**

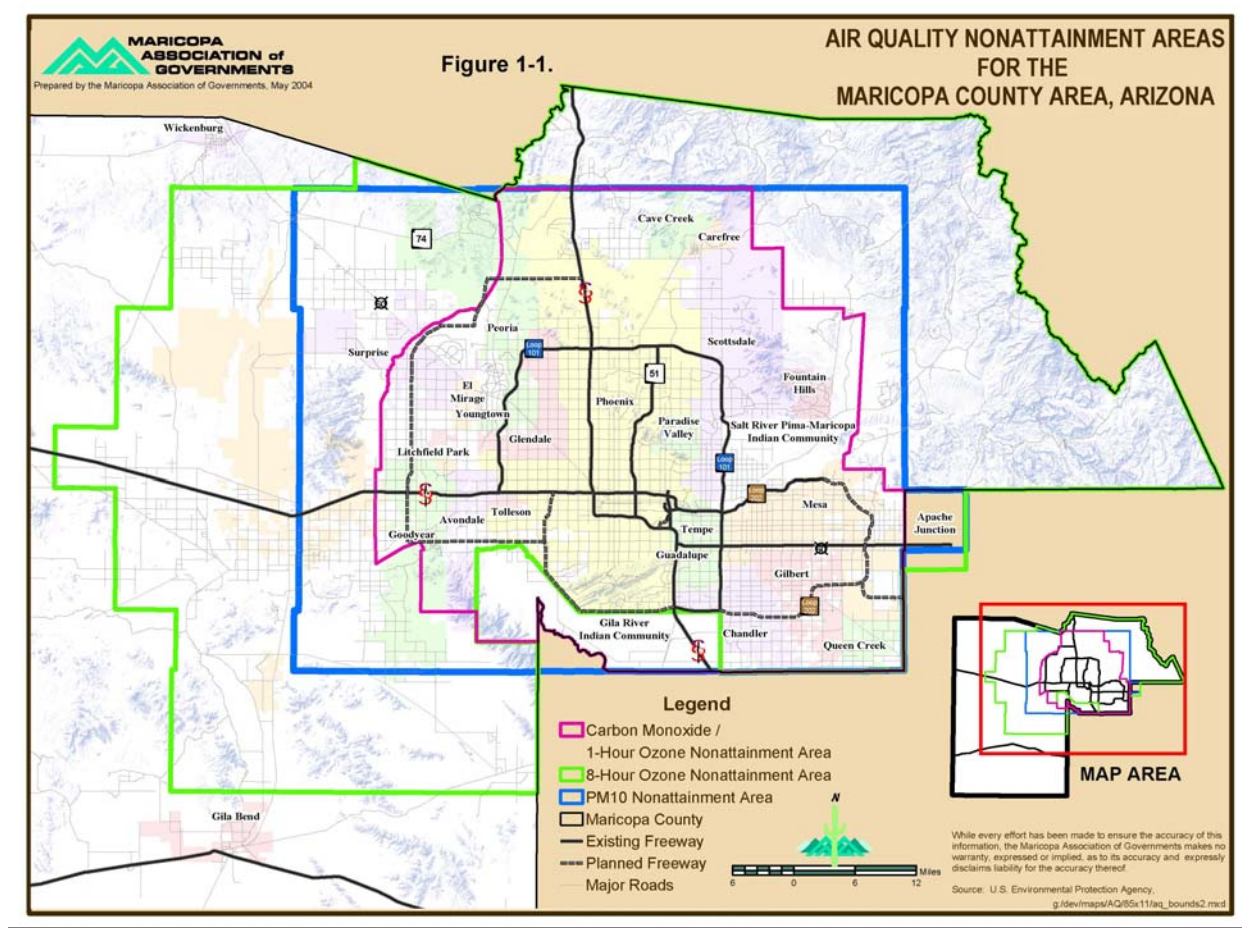
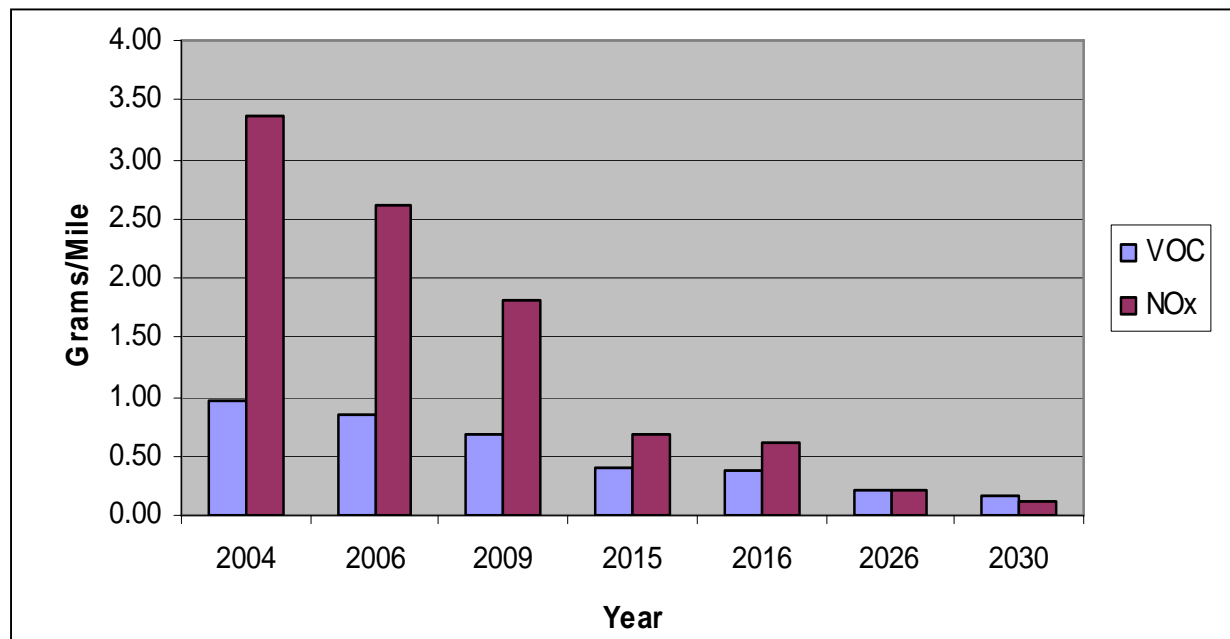


Figure 6 illustrates the average emission rate per vehicle mile traveled for VOC and NO<sub>x</sub> for each of the years in the MAG conformity analysis. As indicated in the figure, improvements in emissions in the vehicle fleet result in significant reduction in the average emission rate per vehicle mile traveled. NO<sub>x</sub> emissions are reduced by roughly 11.9% per year while the VOC emission rate is reduced 6.5% per year. This decrease may also be partially due to a reduced percentage of heavy duty vehicles in the fleet as more resident-based travel occurs in the outlining areas. By way of comparison, the VMT increases from the two forecasts were between 5.1% and 5.8% per year.

**Figure 6: Average Emission Rates by Year for the Donut Area**



When the emission rates from the 8-hour ozone non-attainment area are used the rates of reduction are slightly lower as indicated in Figure 7. Between 2004 and 2030 the average annual reduction in the NO<sub>x</sub> emission rate is 8.9% per year and for VOC is 5.8% per year. Although the Pinal County travel characteristics are likely to be more similar to the travel expected in the donut area, both sets of rates were used to produce emission estimates for both of the two population and travel forecasts to see if ozone precursor emissions increased over time under any set of possible assumptions about rates.



**Figure 7: Average Emission Rates by Year for the 8-Hour Non-Attainment Area**

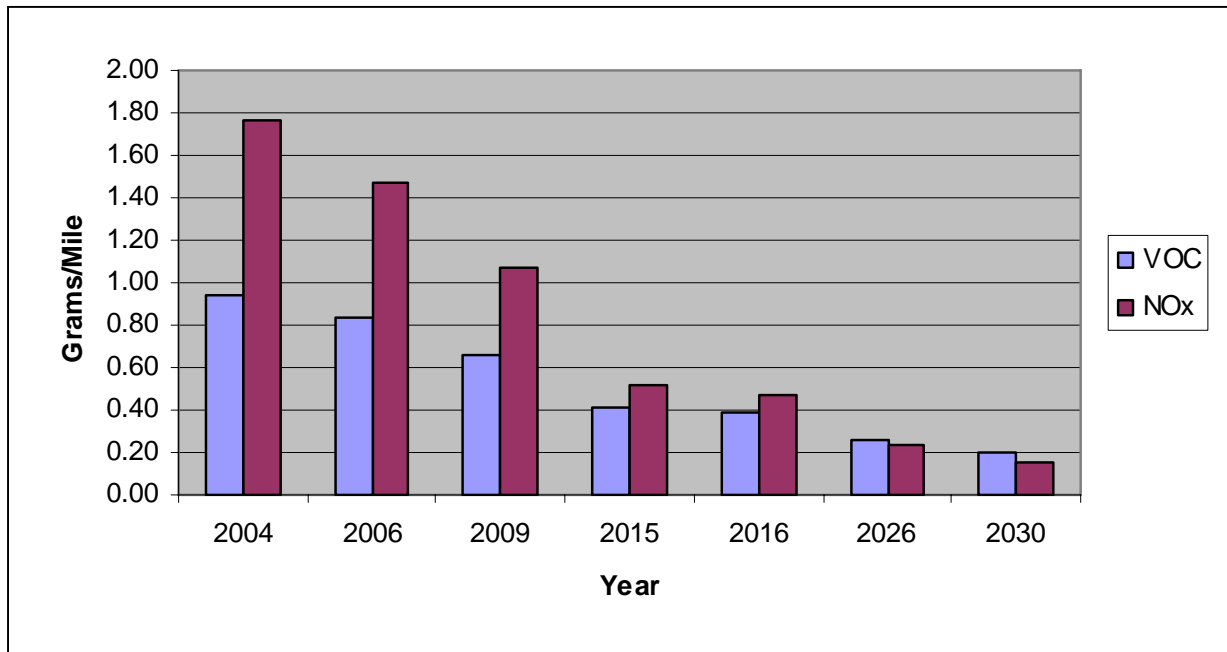


Figure 8 presents the results for the application of the donut area emission rates to the PCPM forecast. VOC emissions are expected to decrease by 26% while NO<sub>x</sub> emissions will decrease 84%.

**Figure 8: Estimated Mobile Source Pollutant Emissions in Pinal County Based on PCPM Forecasts and Donut Area Rates**

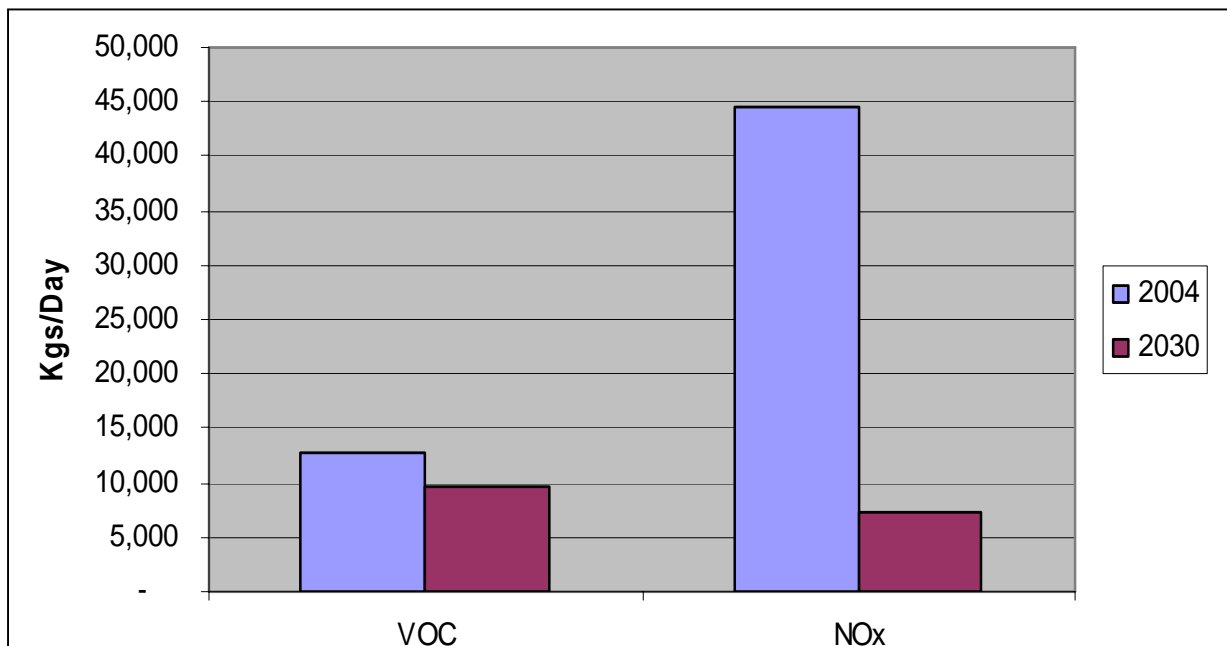


Figure 9 presents the results for the application of the 8-hour non-attainment area rates to the PCPM forecast. In this analysis the VOC emissions would be reduced by 11% while the NO<sub>x</sub> emissions would be reduced by 61%

**Figure 9: Estimated Mobile Source Pollutant Emissions in Pinal County Based on PCPM Forecasts and 8-Hour Non-Attainment Area Rates**

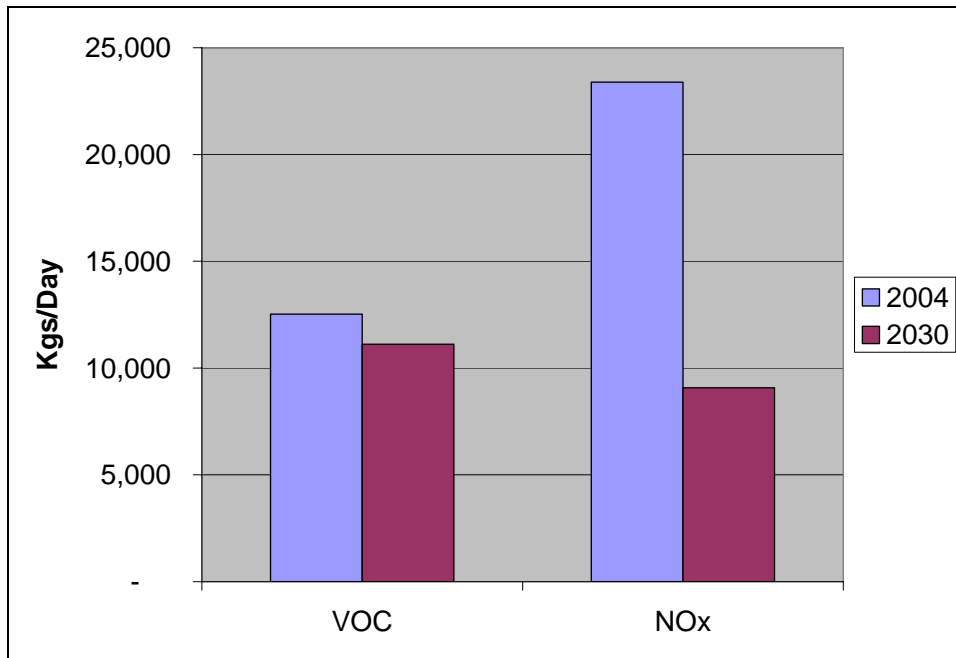
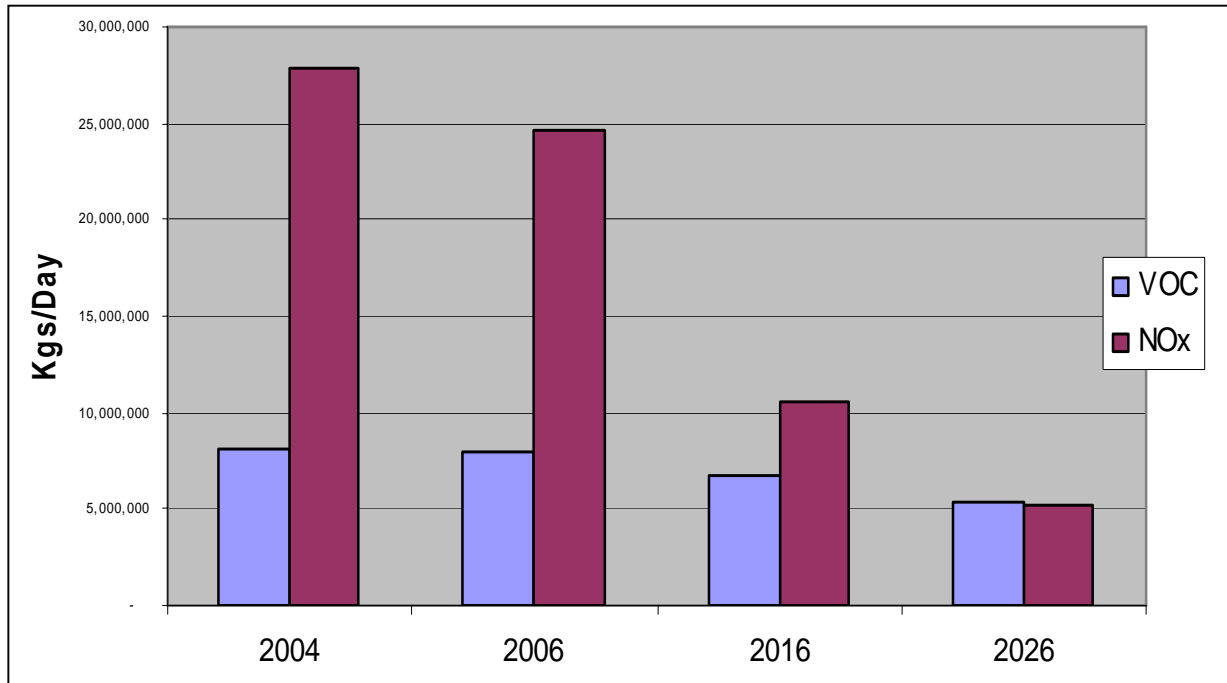


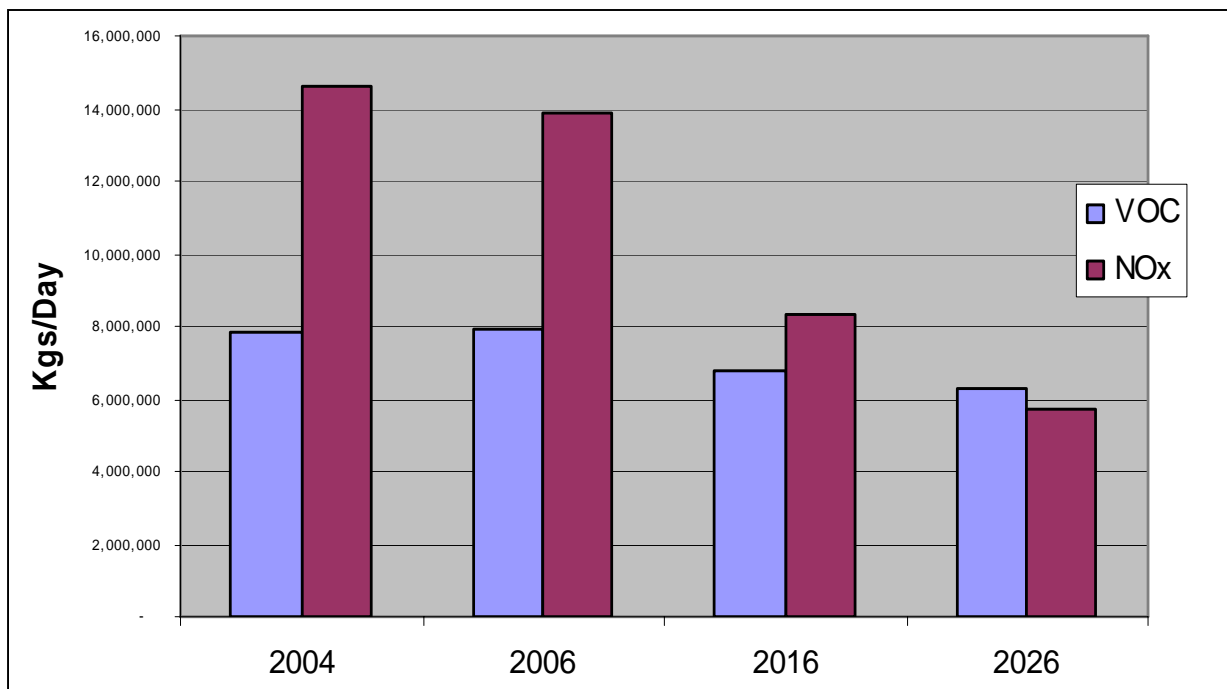
Figure 10 presents results of the application of the donut area emission rates to the MAG forecast and VOC emissions are reduced by 33% while the NO<sub>x</sub> emissions are reduced 81%. When the 8-hour non-attainment area rates are applied to the MAG forecast the reduction in VOC emissions would be 22% as indicated in Figure 11 and the reduction in NO<sub>x</sub> emissions would be 80%.

One additional factor that might affect future emission rates is the average speed of travel. Figures 12 and 13 illustrate how the emission rate for NO<sub>x</sub> and VOC respectively vary for a light duty gas vehicle on arterial roads and freeways. While the curves are fairly flat for both precursor emissions in speeds over 25 miles an hour they can vary significantly at lower speeds. Estimates of future speeds were not available from either of the two forecasting models because at the time of this project neither was being used to test alternative future roadway systems. The speeds for future years will ultimately depend on the degree to which roadway capacity is added, the degree to which trips are connected within the county, and the degree to which alternative modes of travel are provided. If the results of additional planning and travel modeling work for Pinal County suggest that average speeds are likely to be reduced over time, more detailed analysis of the effect on ozone precursor emissions might be warranted.

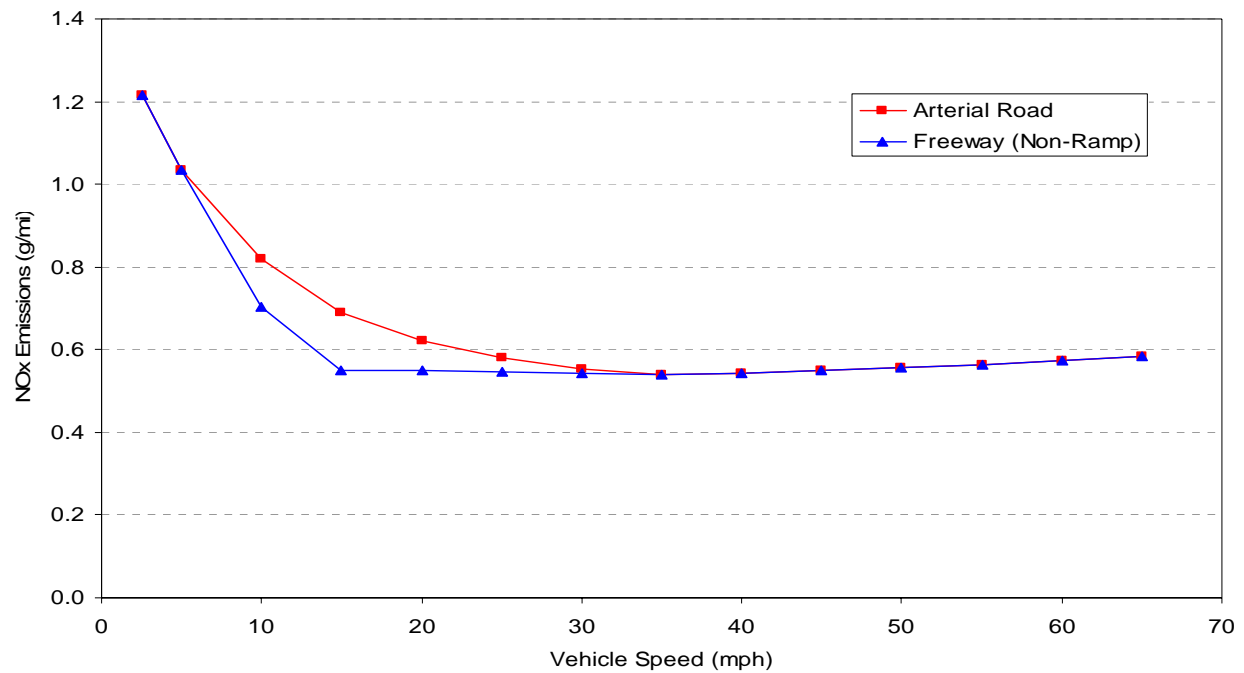
**Figure 10: Estimated Mobile Source Pollutant Emissions in Pinal County Based on MAG Forecasts and Donut Area Rates**



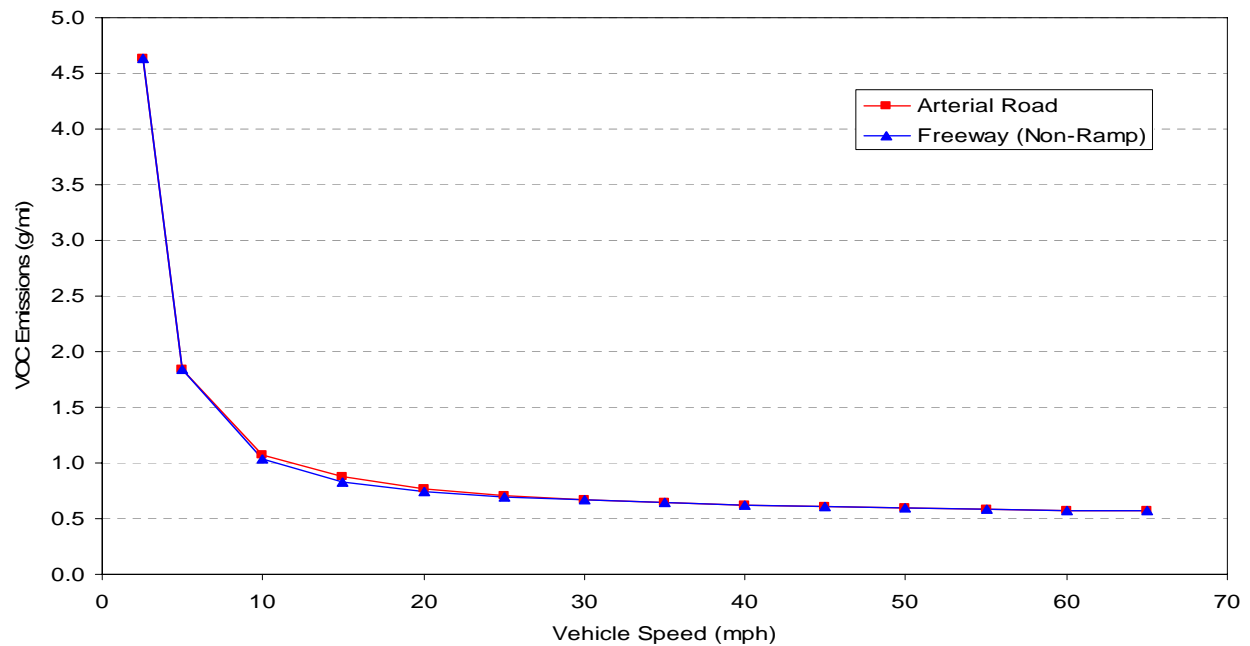
**Figure 11: Estimated Mobile Source Pollutant Emissions in Pinal County Based on MAG Forecasts and 8-Hour Non-Attainment Area Rates**



**Figure 12: LDGV NOx Emissions by Average Facility Speed  
(Mobile6 National Fleet Defaults)**



**Figure 13: LDGV VOC Emissions by Average Facility Speed  
(Mobile6 National Fleet Defaults)**

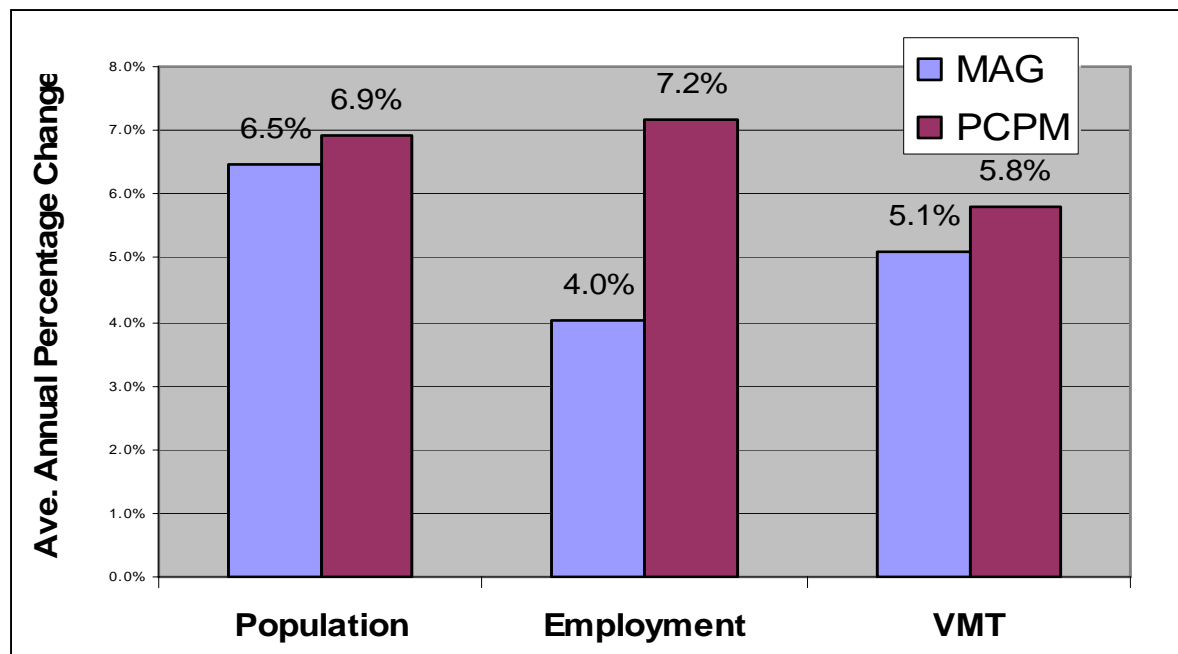


## Conclusions about Future Ozone Production

Based on the analysis of ozone precursor emissions, it seems unlikely that there would be an increase in ozone as a result of travel within or through Pinal County between 2004 and 2030. In each of the scenarios tested using alternative travel forecasts and alternative emission rates the rate of reduction in emission rates was greater than the rate of growth in VMT. This comparison is provided directly in Figure 14. In both cases the rate of VMT growth is less than the annual rate of reduction in the precursor emission rates. In some cases the average annual rate of population and/or employment rate might exceed the VOC emission rate reduction but both travel models are predicting a slower rate of growth in VMT than in population. This is likely the result of a higher percentage of resident travel in the county as opposed to through trips and more trips being linked within the county as more employment and shopping areas emerge with growth in the county.

Although the analysis conducted in this task suggests that an increase in ozone precursor emissions in Pinal County is unlikely over the next twenty years, periodic reassessment of the situation is probably warranted particularly for VOC emissions. Monitoring of growth rates, roadway plans and improvements, travel speeds and emissions rates will indicate whether any of the assumptions of this analysis are no longer valid and a new analysis conducted

**Figure 14: Summary of Average Annual Growth Rates for Pinal County**



**\* By comparison the average annual percentage reduction in VOC emission rates is 5.8% and 6.5% per year and NOx is between 8.9% and 11.9% per year.**